COMMENTS ON PROPOSED SAB BIOGENIC CARBON REPORT (2018)

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These comments are submitted on the proposed report of the EPA Science Advisory Board released August 2018 regarding the accounting of greenhouse gas emissions from biogenic carbon. Because this report focuses on forest-based biomass, we limit our comments to that topic. The authors of these comments have extensive experience and academic writings evaluating bioenergy in the Executive Branch, with the IPCC, and in academic writings. Although time limitations prevented a broader effort at coordination, these comments are also consistent with comments submitted by dozens of scientists and economists prior to the last proposed biogenic carbon report for the SAB in March of 2014. (An extended version of those comments by four of the researchers, including two submitting these reports, is attached as Appendix B.)

Although the new proposed report is an improvement over the last two panel report drafts – particularly in its discussion of timing – the language contains three somewhat related problems which should be corrected:

(1) The report in places could still be read as recommending accounting, including forms of the "reference baseline," that commingle the effects of harvesting wood for bioenergy itself and exogenous effects on forest carbon of other activities and natural fluctuations. These methods would assign undue GHG savings or costs to bioenergy that are unrelated to the effects of bioenergy itself.

(2) The report encourages potential use of a class of models, economic models, that: (a) are inappropriate and unprecedented for the types of regulatory purposes at issue here; (b) have never been validated and are recommended by the SAB without any analysis of whether they could be valid or validated; and (c) include specific reference to models that are not empirically based but are thought exercises in which the more favorable results for bioenergy are hardwired into the modeling assumptions.

(3) The report could be read as suggesting that a single emission factor (BAF) for forest biomass feedstocks be calculated regionally, which would both unfairly

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benefit high carbon sources of biomass and unfairly penalize low carbon sources of forest biomass, such as wood product wastes.

In Appendix A we provide specific recommendations for changes in language to address these concerns.

I. Importance and likely consequences of using wood deliberately harvested for bioenergy

For decades, the world has burned wastes from the production of other wood products for energy, and there is broad agreement that such bioenergy reduces carbon in the atmosphere because it saves fossil fuels without adding carbon to the atmosphere that would not occur anyway and quickly through decomposition. The controversy today concerns efforts to harvest wood deliberately to burn for bioenergy.

In January of this year, roughly 800 scientists and economists submitted a letter to the European Parliament warning that going beyond wastes and instead harvesting wood to burn for bioenergy – including portions of trees otherwise used for wood products – would likely double or triple the quantity of greenhouse gases added to the atmosphere by 2050 for each energy unit of fossil fuels displaced.[1] This letter was written by winners of the U.S. Medal of Science and the Nobel Prize, a former Chief Scientist of the United Kingdom, multiple members of the U.S. and European National Academies of Science, and numerous leaders of the IPCC. They based their work on abundant, peer reviewed papers of biophysical models, which have analyzed the harvest of wood for bioenergy from a wide range of forests, using a wide range of harvesting strategies, a wide-range of processing strategies, and replacing a variety of different fossil fuels. [2–12] Numerous other scientific bodies have reached similar conclusions, including the combined European national academies of science in a recent analysis.[13]

These scientists have also warned that the consequences for forests and the climate of pursuing forest-based bioenergy are likely to be large because it requires a vast quantity of wood to produce a small quantity of energy. For example, all the wood harvested annually in Europe, which roughly matches the annual wood harvest of the U.S. and Canada, could at most generate roughly 5% of Europe's annual primary energy demand.[14] In the U.S., all annual US wood harvest could supply 3-4% of U.S. annual primary energy. On a global basis, all commercial wood harvests (wood that is not already harvested for traditional household fires and charcoal) could supply only 2% of global primary energy.[14] Although developed countries have long used the black liquor and other wastes of wood product generation, which still today supplies the bulk of developed world bioenergy, any move toward directly harvesting wood to burn has high potential to cause vast harm to the world's forests, their ecologies, and their carbon stocks without contributing significantly to our energy supply.

The reasons for the high GHG consequences of dedicated wood harvests for bioenergy are intuitive and explained in plain language in that 800-scientist letter and in a recent, peer-reviewed paper in *Nature Communications* by some of the letter's authors.[14] Wood is an inefficient carbon-based fuel from a GHG perspective. Its harvest necessarily and properly results in much of each tree, such as roots and some small branches, being left to decompose in the forest, which releases carbon without any offsetting savings in fossil fuels. Burning wood is also inefficient compared to using fossil fuels, particularly for electricity due to the nature of its carbon bonds and water content (and any effort to make the wood more efficient by compressing it into pellets loses more wood and generates other energy emissions). Although wood is renewable and could regrow, most forests harvested for wood would also continue to grow (and sequester carbon) for many years faster than a newly re-growing forest. Eventually, the combination of saved fossil fuels and re-growing forests will pay off the carbon debt on the first stand harvested, but it will take more years to pay off carbon debt on additional stands harvested in subsequent years. Overall, according to multiple estimates by multiple authors of multiple independent researchers, and despite variations in the details, it will take decades to centuries for wood harvested directly for bioenergy to even match the emissions of fossil fuels and many more years to generate substantial carbon savings.[2–12] All of this of course assumes that forests are maintained as forests, and there is no reason that has to be true.

This conclusion should be no surprise to anyone who recycles used paper. Three decades ago, this country went through a major debate regarding whether it was better to recycle used paper or to burn it for energy. The correct conclusion was that recycling was better for the environment largely because it saved the trees otherwise devoted to paper production. The recommendation of some to burn wood directly as a whole uses wood of pulpwood quality, precisely the wood saved by recycling, and is in effect a recommendation that the country should burn the trees saved by the recycling efforts of tens of millions of Americans (and potentially far more trees too). Any analysis that claimed to justify such efforts on GHG consequences would also claim that the recycling of used paper is an environmental (or at least GHG) mistake. For the reasons described in the previous paragraph, it is not.

However, it is important to recognize that this finding does not mean that there are no possible increases in forest-based bioenergy. If additional wood in the future were harvested for wood products, e.g., for construction, which could occur because of market forces or even because of some climate strategies to replace steel or concrete, that process will generate more forest-based waste for bioenergy use. For this reason, it is also important that bioenergy accounting distinguish among different sources of biomass.

II. Commingling of Exogenous and Endogenous Effects

The greenhouse gas emissions from bioenergy can be accounted for by examining the changes it causes in terrestrial carbon storage (just as fossil fuel emissions could in theory be counted by changes in underground carbon storage.) If that is done, a critical factor for sound accounting is to account only for the changes caused by bioenergy and not commingle it with exogenous changes. This very simple distinction between analyzing the “consequences” of bioenergy and exogenous forces explains why the first full SAB report rejected EPA’s proposed use of the so-called “reference baseline.” The essence of the SAB’s first biogenic carbon report based on the 2011 proposed EPA framework was that the proposal from the agency would commingle effects of bioenergy and other changes in forest carbon. It would thereby improperly credit carbon savings to bioenergy that would occur independently and sometimes possibly improperly assign carbon costs that were not caused by bioenergy.

The basic point is simple: all analyses of any discrete action, whether bioenergy or any other, need to segregate the effects of that action from exogenous effects. The problem with EPA's reference baseline is that it commingles these effects. In part to assure this distinction is clear, we recommend that the report include explicit language about distinguishing the effects of bioenergy from other effects and provide some suggested language in our appendix.

EPA originally recommended a so-called "regional reference baseline" approach, which if we understand correctly, meant that in each region EPA assumed that any future harvest of wood that did not reduce carbon stocks below the existing baseline would be deemed to be carbon neutral. That approach commingles the effects of bioenergy production and the effects of exogenous factors. In particular, the world as a whole and most regions, including the United States, are gaining forest carbon.[9] This sink adds roughly one gigaton of carbon every year to the world's forests and therefore removes that amount of carbon from the atmosphere. Under the "regional reference baseline" approach, enough wood could be harvested for bioenergy to entirely negate this sink, and that would be considered "carbon neutral." Ton for ton, removing wood and burning it adds carbon to the atmosphere regardless of whether there would otherwise be an exogenous net sink or an exogenous net loss.

Other exogenous effects are also commingled in this baseline, which could either unfairly and inaccurately advantage or disadvantage bioenergy GHG calculations. For example, what if a forest area is experiencing decreasing carbon stocks due to other wood harvests? That does not mean that using all forest biomass is incrementally harmful for the climate, and the prominent example is the use of wood wastes from wood production. If those wastes were going to decompose quickly anyway, using them for bioenergy does not add carbon to the atmosphere over a policy-relevant time line and that is true regardless of whether regional forests are gaining or losing carbon stocks without bioenergy. Alternatively, a reference baseline may build in an existing level of wood harvest, and that harvest may decline in the future for any of a number of reasons, such as a slowdown in the US housing market or an influx of cheap imports. This increase in carbon would not be created by the bioenergy and would increase carbon stocks without bioenergy. Again, the bioenergy harvest would increase carbon in the air although it would be inappropriately credited with the carbon gains from this exogenous market change.

It is for these reasons that the SAB's previous report found the use of a reference baseline to be fundamentally inaccurate and recommended instead an anticipated baseline approach. Although the terminology of an anticipated baseline may be unnecessarily complex, the key point is to compare bioenergy with the lack of bioenergy alternative. The standard way in which multiple researchers have modeled the effect of bioenergy is to analyze the different kinds of forests and individual trees potentially harvested using biophysical growth models. They use these models to compare forest carbon stocks with and without the bioenergy harvests and how those carbon stocks would change over time assuming forests are allowed to regrow. These papers generally use as landscape approach by examining the removals that will occur over time across the landscape.[3]

Our concerns with the new report are that it appears to resurrect problems the previous report was designed to prevent. Some of this language may be inadvertent. For example, on page 11, line 8, the report reads: “If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing.” This language is problematic because it might be read as implying precisely that bioenergy harvests could expand to a level that eliminates a forest’s exogenous growth and therefore its carbon sink and still be treated as carbon neutral. Appendix A to these comments goes through the text line by line and suggests deletions or modest additions to insure that the focus is on the incremental effects of the bioenergy harvest.

The most problematic language is on page 2 in language that explicitly resurrects the reference baseline approach without justification: It states: “The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB’s earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.”

We fail to see how mere adjustment over time of the reference baseline addresses the problem of commingling endogenous and exogenous effects. The reference baseline, as EPA has defined it, is the existing carbon stock at the time of the regulatory analysis. In other words, for a power plant permitted in 2018, the reference baseline applied regionally would be the carbon stocks of forests in the region. If the forest would grow and accumulate carbon over time without bioenergy (which is true of American forests as a whole due to the forest carbon sink), bioenergy would be allowed to expand up to the point that it eliminates this forest carbon sink. In fact, if the carbon stock is going to change for any reason just comparing the bioenergy harvest scenario with the carbon stock in place in 2018 cannot isolate the effects of the bioenergy harvest. I region that is losing carbon for reasons unrelated to bioenergy, this approach would also unfairly tar the bioenergy harvest with additional emissions it did not cause.

In addition, as a practical matter, we cannot see how adjustment of the reference level over time could alter the consequences. A power plant will be permitted based on an initial analysis. Is the report suggesting that if the carbon stock changes in five years, the permit should be rewritten? And what about the previous years? If they turned out to have been based on false premises, should the power plant be fined? If not, the original decision to allocate the forest carbon sink to bioenergy is permanent. If the power plant is fined, it could be blamed for changes in forest carbon that have nothing to do with bioenergy, such as poor growing weather or an increase in the U.S. housing market, stimulating further wood harvests for timber.

This reference baseline could be an extremely large loophole crediting bioenergy that actually increases emissions with reductions because power plants are allowed to claim the exogenous forest carbon sink as a credit. For example, if this rule were applied globally, given the size of the global forest sink, it would allow a tripling of global commercial wood harvest.[14] Any valid scientific rule has to be valid everywhere.

The solution is always to focus on the incremental effect of the bioenergy harvest. That is best done using the methods employed in the many biophysical modeling papers identified in references 2-12. As noted, in Appendix A, we recommend specific language changes to delete the problematic language.

III. Inappropriate and Not Validated Endorsement of Economic Models

The report endorses the potential use of economic, and not merely biophysical, models for analyzing the carbon consequences of bioenergy. The inappropriate use and lack of scientific support for these models was a major focus of joint comments submitted by dozens of scientists and economists to the SAB in 2014. Those comments also offered particular explanations about the FASOM model used by EPA. The new draft properly recommends against the use of the FASOM model as not validated but suggests that other, unspecified models might be used. For the following reasons, we recommend that this endorsement for the use of economic models in this context be deleted.

A. Inappropriate and unprecedented regulatory use

The economic models at issue, whose results tend to vary widely, incorporate into the analysis of bioenergy actions by other people and on other land claimed to be stimulated by increased prices caused by the addition of bioenergy demand for wood. For example, the model may estimate that use of wood for bioenergy diverts wood that would otherwise be used for paper and cardboard production and reduces their consumption, which reduces harvests and loss of terrestrial carbon. The model may also estimate that due to higher prices other landowners manage forests more intensively to grow faster or even plant more forests. Both effects in and of themselves cause gains in carbon stocks, and the model counts those credits as offsetting losses of carbon due to harvest for bioenergy.

The best way to understand why this use of economic models to regulate power plants, factories and other "stationery installations" is inappropriate is to think of standard regulation of a steel plant. If a new steel plant is built, regulations always count its emissions, and not merely of CO_2 but of SO_2, NOx and other pollutants. Regulators do not run an economic model, estimate for example that the new steel plant will put an old steel plant out of business or reduce its production, and then deduct those reduced emissions from the emissions of the new steel plant For the same reason, regulators also would not use an economic model that might estimate that the new steel plant will cause changes in other markets that might increase emissions from other sources and attribute those emissions to the steel plant.

Similarly, if a steel plant directly diverts coal from an existing mine that would otherwise go to another factory or power plant, regulators do not count that coal as emission-free on the theory that it would be burned otherwise by another plant. They count the emissions from the coal and assume instead either that the other factories and power plants would burn replacement coal or just that by assigning responsibility to each user, regulators will ultimately have a more rational and comprehensive regulatory approach.

Regulation of stationery installations does not work this way because the best way to regulate is to hold each source accountable for its own emissions. The alternative structure also creates a high risk of double-counting. For example, if a landowner plants a forest, even if due to higher prices due to bioenergy demand, the credit is typically assigned to the landowner not the consumer of bioenergy. And for these reasons, we should assign the costs of harvesting wood to the bioenergy user regardless of these economic effects. Regardless of such effects, bioenergy is using wood removed from the forest for bioenergy and bioenergy should be assigned any reduction in carbon stocks that directly result from that wood removal.

The point is not that such economic models, to the extent valid, could not have some policy uses. For example, policymakers might wish to run such a model to estimate rebound effects of policies in many contexts. Such analysis might work at the scale of evaluating entire regulatory programs. (There may even be some valid uses of such approaches in types of lifecycle analyses.) But the policy at issue here involves the accounting of emissions from stationary installations. There is no reason to treat bioenergy differently from any other source of fuel.

B. T**he SAB has undertaken no analysis of the potential validity of these models.**

The use of some kind of model is inherent for scientific calculations, but before the SAB recommends use of a class of models for regulatory purposes, it should carefully evaluate them and have a sound basis for determining that they could be sufficiently valid to be used for the regulatory purpose. That is particularly true when the SAB has received comments from distinguished economists and scientists to the contrary. We draw the SAB's attention again to comments previously submitted by economists and scientists and attached as Appendix C. The gist of these comments was: (a) that there are simply too many unknown parameters to construct an empirically grounded model of the kind that some others have been using to estimate biogenic carbon effects, and (b) that these models in part as a result also leave out critical effects that have the consequence of assigning "free" biomass or land for bioenergy use, e.g., by assuming diverted wood products or diverted agricultural land are not replaced. Previous comments have also pointed out that to our knowledge, none of these models has been validated in any meaningful way.

Indeed, before an economist can claim validity for a predictive model, economists should at least be able to reproduce prior effects of changes in wood biomass demand using proper econometric methods to isolate the effects of that demand. We are also not aware of any proper econometric studies that have validly analyzed such effects in the past.

Without careful analyses of these questions in this report, even if economic models were appropriately used for these kinds of regulatory purposes, we believe it would be inappropriate for the SAB to recommend their use.

C. The Cintas et al. paper cited is not a true economic projection but a constrained thought experiment in which the results are dictated by the assumptions.

The proposed report cites one "economic model" used by Cintas et al. [15], implicitly approves of it, and claims it establishes that bioenergy harvests for bioenergy can sometimes result in immediate forest carbon gains. But this model is not truly capable of making that prediction. In fact, this paper does a good job of illustrating what is going on in many other economic models that claim the potential for short-term GHG benefits. The assumptions built into the modeling in Cintas et al. can have favorable results for bioenergy because they require that additional wood harvest within a forest be offset by more intensive forest management or reductions in other wood consumption, both of which add to terrestrial carbon storage.

If we understand the modeling in that paper correctly, it models one defined area of forest only and three important assumptions: (1) all land within that forest area even without bioenergy will eventually be cut and is already managed optimally to generate economic returns, (2) the demand for additional wood for bioenergy continues indefinitely into the future, and (3) the additional wood for bioenergy cannot be produced by harvesting wood either in this forest that would otherwise not be cut (because it would all be cut anyway) or by harvesting wood from another forest that would otherwise not be cut. The effect of these assumptions is to preclude the possibility in the model that the increased demand for wood to meet the bioenergy demand would be met just by harvesting more trees that would otherwise not be cut. Because that new bioenergy demand is permanent and fixed, the only ways the model can meet this demand are for it to project that other forest owners will manage their land more intensively or that bioenergy will divert wood from other uses that are not replaced. These assumptions are just pure assumptions and not based on any empirical analysis.

The main options these analyses leave out is the option to provide wood for bioenergy just by cutting more trees that have grown and would grow anyway. On both global and most regional bases, there is no need to plant more trees or intensify wood production to meet increases in bioenergy demand because forest carbon stocks are growing. That is particularly true because bioenergy does not require straight trees, which is a typical goal of forest plantations. In addition, the assumption of a permanent increase in bioenergy largely precludes the model from estimating that forest owners would just cut more trees to meet a one-time or short-term increase in demand. In reality, not only are many forest bioenergy policies explicitly temporary but landowners are likely to discount any prospect of future bioenergy demand due to many inherent uncertainties and therefore likely to harvest more trees quickly to take advantage of a market opportunity that has no guarantee of long-term continuation.

This discussion illustrates how easy it is for modeling to be built on assumptions that are not empirically derived but that drive results. (In fact, we believe that other economic models that also show relatively short-term benefits for forest-based bioenergy work through a similar approach.) It is not that the results in Cintas et al. are not interesting, but they are not grounded in any capacity to predict real, empirical consequences. The discussion of the results in Cintas et al. should be removed from the draft.

IV: The report should recommend distinguishing among different sources of forest biomass feedstocks

The use of different types of forest biomass will have different GHG consequences. Although the harvest of additional stemwood will likely increase carbon in the atmosphere for decades to centuries, the use of wastes from wood processing should decrease emissions quickly, and the use of true residues are likely to have intermediate effects.

Although unclear, there are places that the report could be read to endorse one GHG assessment for all forest biomass in a particular region based on (again) presumably economic projections of the likely types of forest biomass that will be used. In addition to other problems identified above, this approach would shape incentives incorrectly. It could make biomass from wastes that would achieve quick GHG reductions look worse than they are while making wood deliberately harvested to burn look better than it is.

We therefore recommend that the report explicitly recommend distinguishing among different types of feedstocks, and it should calculate these emissions based on the harvests of wood actually supplying a particular facility.

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Appendix A
To the Comments of Phil Duffy, William Moomaw & Tim Searchinger

Page 2: Delete and replace language as follows: "~~The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to 12 account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.~~ Whatever baseline is used, it must be coupled with a modeling structure that evaluates only the incremental effects of the bioenergy use and does not credit or penalize bioenergy for exogenous factors." *Explanation: Throughout the report, there is a potential for confusion on this fundamental point. The principal error with the original EPA proposal, which was pointed out by the first full SAB report on this issue, was that it confused the incremental effects of bioenergy and exogenous factors and therefore credited bioenergy offsetting carbon gains that are due to the overall U.S. forest carbon sink which is occurring and would occur anyway.*

Insert page 2: line 32: the following:

"Assuring analysis only of incremental effect of bioenergy:

Carbon impacts of bioenergy must be based on the incremental change in carbon stocks on the land associated with a particular stationary facility. That change must not include any changes that would occur anyway, for example carbon sequestration (or losses) that would occur somewhere due to forests regrowth from harvests prior to the operation of the facility, to climate change, or to changes in harvest levels for uses other than bioenergy. Modeling must assume those "anyway" changes in the business as usual baseline. Put simply, emissions from bioenergy should be due to the biophysical effects that result from the bioenergy harvest alone and not exogenous changes." *Explanation: This language will assure that notwithstanding any other ambiguous, exogenous changes in carbon stocks are not assigned to bioenergy.*

Page 9: line 2: "It is the balance of losses and credits that determine carbon stock effects" should be changed to "It is the balance of losses and credits that result from the incremental effects of the bioenergy harvest that determine carbon stock effects."

Page 9: line 2-10 Delete line 2 from “Moreover” to end of line 10. *Explanation: This language endorses use of economic modeling.*

Page 9: line 14: Sentence should be changed as follows: “~~We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, policy, market forces, or natural causes~~.” <u>We also underscore our caution that the regrowth of forests harvested for bioenergy should not be assumed without appropriate guarantees that the land will be managed for tis regrowth</u>.” *Explanation: There are several problems with this language. First, it does not clearly distinguish exogenous from endogenous effects of bioenergy. In addition, once bioenergy is burned, there no way to unburn it. It is unlikely that regulators will penalize or reward a stationary installation for other changes. Therefore, the real issue is forward-focused and should insure that if regrowth is counted in a bioenergy model, regrowth is extremely likely to occur*.

Page 2, line 21: delete “economic and”: Explanation: This language appears to encourage inappropriate and unjustified use of economic models to claim credits for bioenergy achieved by other people and on other lands.

Page 2: line 46. Add at the end: “The BAF and greenhouse gas consequences of different feedstocks should be separately calculated to assure that those using feedstocks with larger greenhouse gas benefits are appropriately rewarded and incentive and those who use feedstocks with higher costs or lower benefits are not.” *Explanation: At the present, the draft appears to suggest that one BAF should be assigned to all forest biomass in a region. Doing so would improperly incentive feedstocks than increase emissions over relevant time periods and improperly disincentive feedstocks that reduce emissions.*

Page 10, line 1: insertion of the following two words “the difference in carbon stocks between the reference (<u>no bioenergy counterfactual</u> baseline) and the increased biomass . . . “ *Explanation: Without this language, it is not clear exactly what the baseline is.*

Page 10: delete lines 4-8: *Explanation: The indirect effects language is vague and should be covered separately as we suggest in language above.*

Delete page 11 from “If” in line 8 to the end. “~~If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the reference scenarios, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.”~~ *Explanation: This language does not properly distinguish between exogenous changes going on in a forest and the incremental effects of the bioenergy. In addition, it suggests that simply diverting wood from other forest uses to bioenergy means the bioenergy is carbon neutral when we should instead assume it would be replaced both because that is likely to occur, because any reductions in consumption are likely to have their own carbon consequences as people use alternative goods, and because regulations focused on emissions intensity should not be based on changes in consumption due to price fluctuations.*

Cut page 11, lines 13-28. – “~~Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for bioenergy can lead to a diversion of biomass from those products to energy use and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass by stationary facilities can lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time. When agricultural feedstocks that are harvested annually from land under continuous production, the time lag between harvest, CO2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the reference scenario. The demand for bioenergy can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).~~”*Explanation: This language endorses economic modeling implicitly through the “anticipation of future demand for biomass” sentence. It also includes an inadequate discussion of what you do when bioenergy diverts cropland or crops, which if addressed, should be addressed much more carefully and thoroughly.*